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phases, and not again during the anaphases. The exact manner of division of the chromosomes seems to agree with that described by Miss FRASER, but on the basis of certain stages, which he thinks were missed by her, he interprets his results in a different way. He describes a synapsis stage, whose loops correspond to the V-shaped chromosomes, which later appear on the spindle in the equatorial plate. Although he does not very strongly insist on this point, he is inclined to think that the scheme of chromosome reduction described by FARMER and MOORE for higher forms of plants and animals obtains in the ascomycetes. In the first part of the paper an interesting discussion of the state of these questions and other problems relating to the ascomycetes will be found.—J. B. OVERTON.

Anaerobic growth.—LEHMAN[29] has studied anaerobic growth in higher plants, trying to determine whether the view of WIELER or that of NABOKICH is correct. WIELER claims that the higher plants will not grow in total absence of oxygen, but that only a very low oxygen pressure is needed for growth. NABOKICH claims that higher plants will grow in absence of oxygen. He maintains, however, that proper nutritive conditions must be supplied, as in fungi. For this purpose a glucose solution is suitable. This solution certainly increases anaerobic growth in the pea seed, sunflower seedling, and other forms. In a later article, not cited by LEHMAN, NABOKICH[30] describes the course of anaerobic growth in higher plants. Soon after placing the organ in the oxygen-free medium, growth ceases (Vacuumstarre). Somewhat later growth begins, and the rate rises until it equals that of aerobic growth. Still later growth ceases and death of the organ ensues. NABOKICH explains the course of anaerobic growth as follows: oxygen acts as a stimulus to growth, and not merely as an energy releaser, hence with its withdrawal growth ceases; intramolecular respiration later produces poisonous by-products, which in low concentrations act as stimuli to growth, but which with further accumulations stop growth and kill the organ. The bad feature of this explanation is the indefiniteness of the term stimulus. NABOKICH finds that resting plant cells or those with low metabolic activity can remain in oxygen-free condition for long periods without injury.

LEHMAN found only very slight if any anaerobic growth in *Vicia Faba*, *Pisum sativum*, *Lupinus albus*, *Brassica Napus*, *Phaseolus multiflorus*, and *Cucurbita*, either in distilled water or glucose solution. In *Zea Mays* and *Glyceria fluitans*, anaerobic growth was marked in glucose solution, but was nil in distilled water. In *Helianthus annuus*, anaerobic growth was slight in distilled water, but considerable in glucose solution. LEHMAN concludes that anaerobic growth in any higher plants is not long-enduring nor considerable when compared with aerobic growth. He also finds no coincidence between intensity of "intramolecular" respiration and of anaerobic growth. The conclusions of these workers are drawn from too few and these mainly cultivated forms. Study of wild forms of varied habits may show very different results. —WILLIAM CROCKER.

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[29] LEHMAN, ERNST, Zur Kenntnis des anaeroben Wachstums höheren Pflanzen. Jahrb. Wiss. Bot. **49**:61–90. 1911.

[30] NABOKICH, A. J., Ueber die Wachstumsreize. Beih. Bot. Centralbl. **26**:7–149. 1910.

Structure of the spore wall.—A notable addition to our knowledge of the structure and development of the spore wall is contributed by BEER[31] in a study of the young pollen grains of *Ipomea purpurea*. At the conclusion of the reduction division, the tetrads of young pollen grains become surrounded by massive mucilaginous walls, which show the reactions of callose and pectose. Within this mucilaginous wall, and surrounding each young pollen grain, is another mucilaginous wall with the same reactions. This second wall is called the "special wall," a term suggested by STRASBURGER to replace the awkward and misleading term "special mother cell wall." The exine is deposited by the pollen protoplast upon the inner surface of the special wall, and at first is homogenous, but soon becomes differentiated into an outer lamella, with a network of thickening bands on its inner surface, and at the intersection of the bands are the rudiments of the spines. At this stage a clear space is seen between the outer lamella and the thickening bands, and in this space the rodlets characteristic of the mature pollen develop. The spines project into the pollen cavity before they begin to appear externally. The intine develops within the exine as a thin layer, with thicker portions where it protrudes into the exit pores. Chemically, it consists of pectic bodies associated with some cellulose. In older pollen grains the exine consists of a delicate outer lamella perforated with countless pores, so that it really forms a reticulum with open meshes, beneath which are the thickening bands constituting the mesospore, perforated by the narrow exit pores for the pollen tubes. The outer lamella of the exine dips into the exit pores and covers the protrusions of the intine at these spots. Since nearly the entire growth of the rodlets and spines takes place after they have become separated from the protoplast, it is concluded that they are able to develop without any direct contact with the protoplasm.

This short paper presents a thorough study of a single species and suggests a series of investigations, for it may be predicted with the utmost confidence that the account will not hold for angiosperms in general, and the author makes no such claim. After various types of pollen grains have received similar attention, it will be time to generalize.—CHARLES J. CHAMBERLAIN.

Chemotaxy.—SHIBATA[32] gives the first part of a full statement of his extensive work on chemotactic responses of the spermatozoids of pteridophytes. This

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[31] BEER, RUDOLF, Studies in spore development. Ann. Botany **25**:199–214. *pl. 13.* 1911.

[32] SHIBATA, K., Untersuchungen über die Chemotaxis der Pteridophyten Spermatozoiden. Jahrb. Wiss. Bot. **49**:1–60. 1911.